CC Technical Documentation
RM-11 Series Transceivers

Troubleshooting - RF (Part 1)

Issue 1 02/2004
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RF Troubleshooting

The RM-11 features 1900MHz PCS CDMA, 800MHz Cell CDMA and AMPS, an internal antenna, GPS, an FM radio, a RUIM card, a color LCD, a VGA camera, and a flashlight.

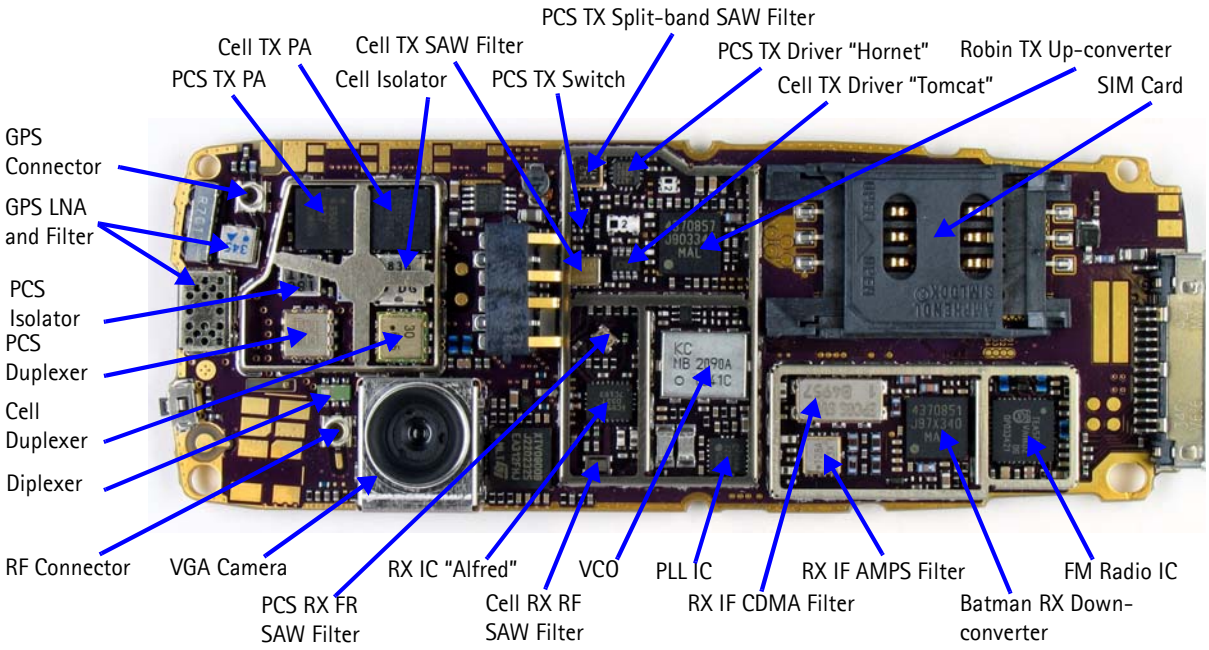

Figure 1: RM-11 RF components

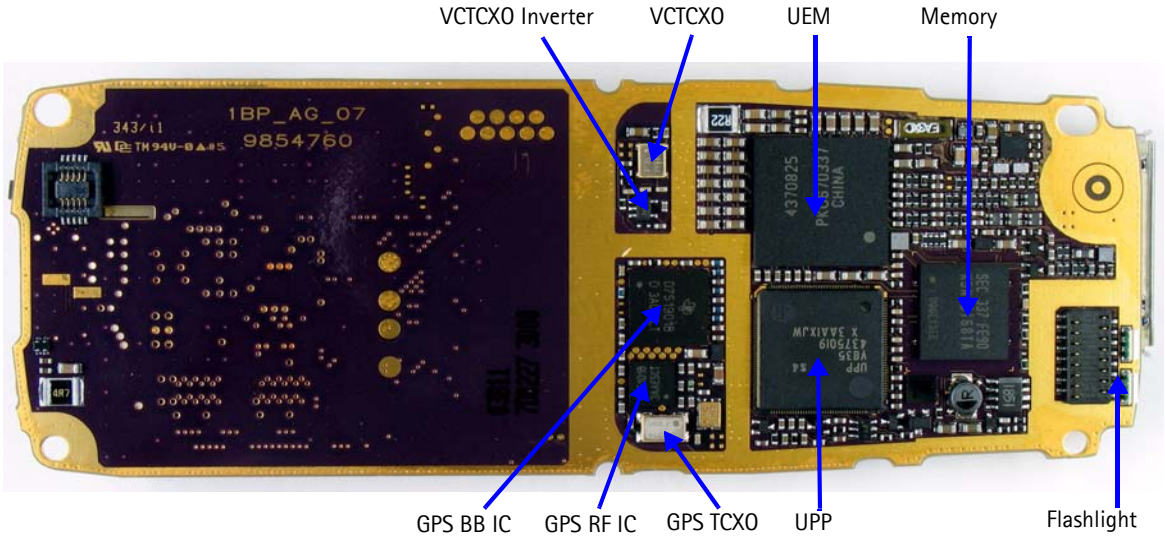

Figure 2: RM-11 Baseband components

Equipment List for RF Troubleshooting

Use the following equipment to troubleshoot the RM-11 RF:

- Computer with Phoenix
- Agilent 8960 CDMA call box

Note: (If 8960 is not available, then a Signal Generator is needed.

- Power supply
- Diagnostic test jig
- RF connector snap cable
- Spectrum analyzer
- Active FET probe
- Tomahawk headset and universal headset for FM radio

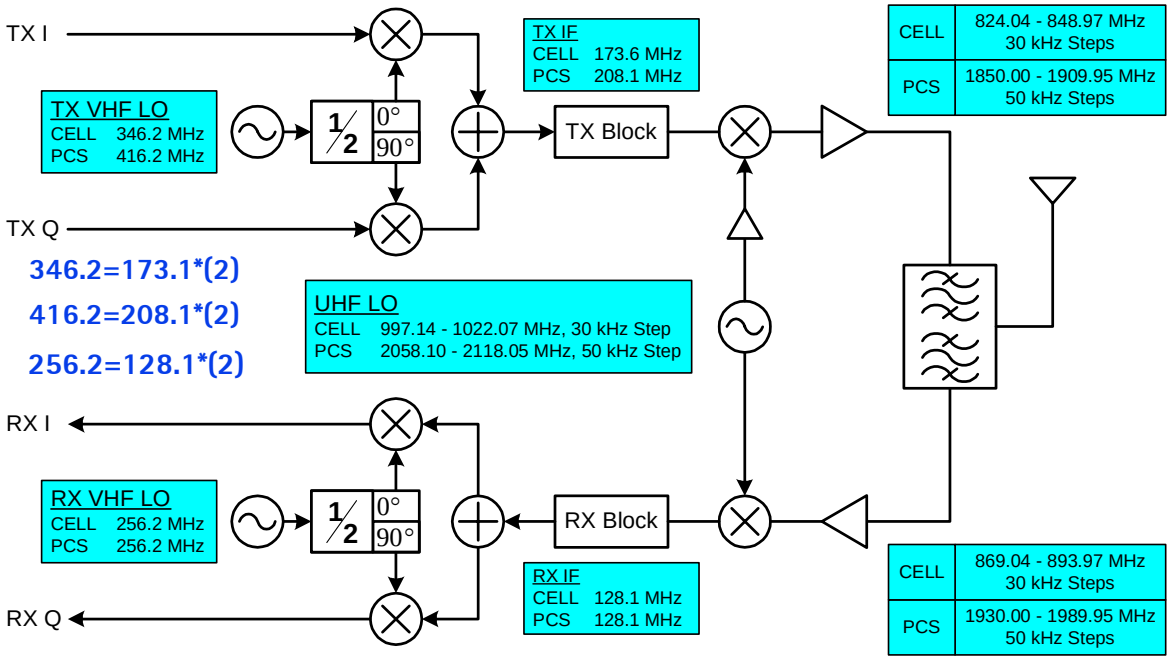

Figure 3: RF troubleshooting equipment diagram

Phoenix Service Software

In the RF environment, Phoenix SW provides 10 components for troubleshooting:

- Phone Control in DSP
- RF Main Mode in RF
- CDMA Control in DSP
- RF PDM in RF
- Gen I/O in RF
- RF Register R/W in RF
- UHF Synthesizer in RF
- Batch Tune in RF
- RF Tuning in RF
- RF AGC Status in RF

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RF (Manual Control) Components in Phoenix

① Phone Control in DSP

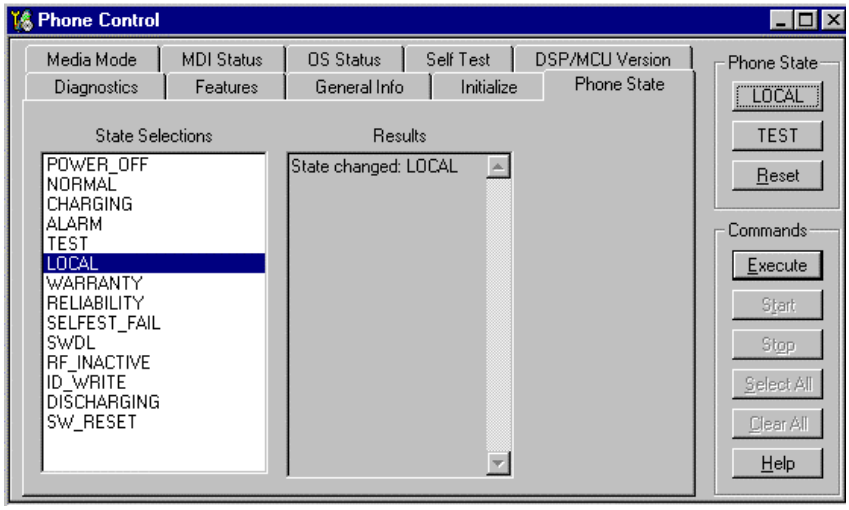

Figure 4: Phone Control dialog box in DSP

② RF Main Mode in RF

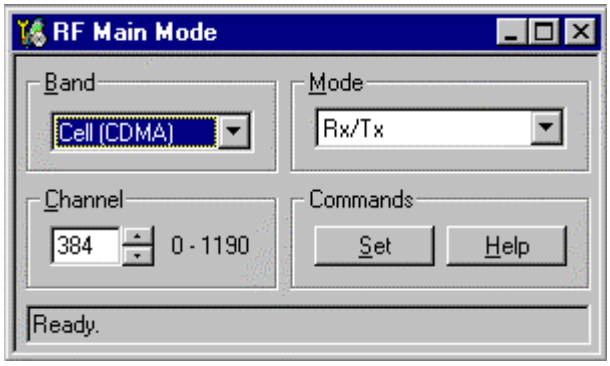

Figure 5: RF Main Mode dialog box in RF

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③ CDMA Control in DSP

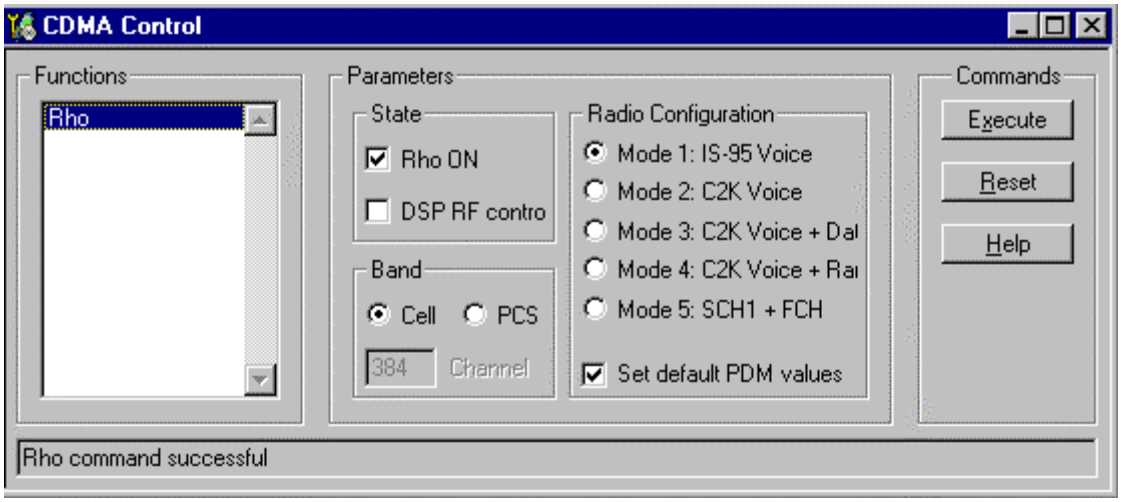

Figure 6: CDMA Control dialog box in DSP

④ RF PDM in RF

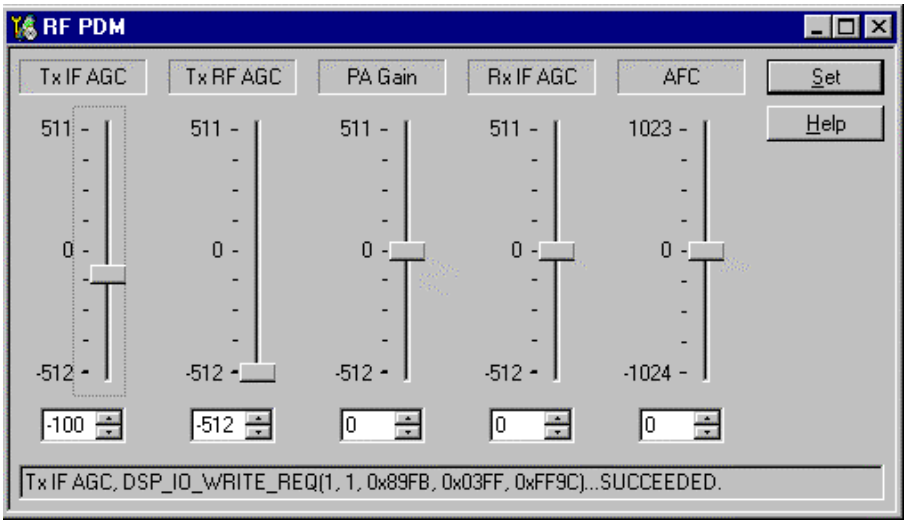

Figure 7: RF PDM dialog box in RF

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Observing Tx Output Spectrum on Analyzer

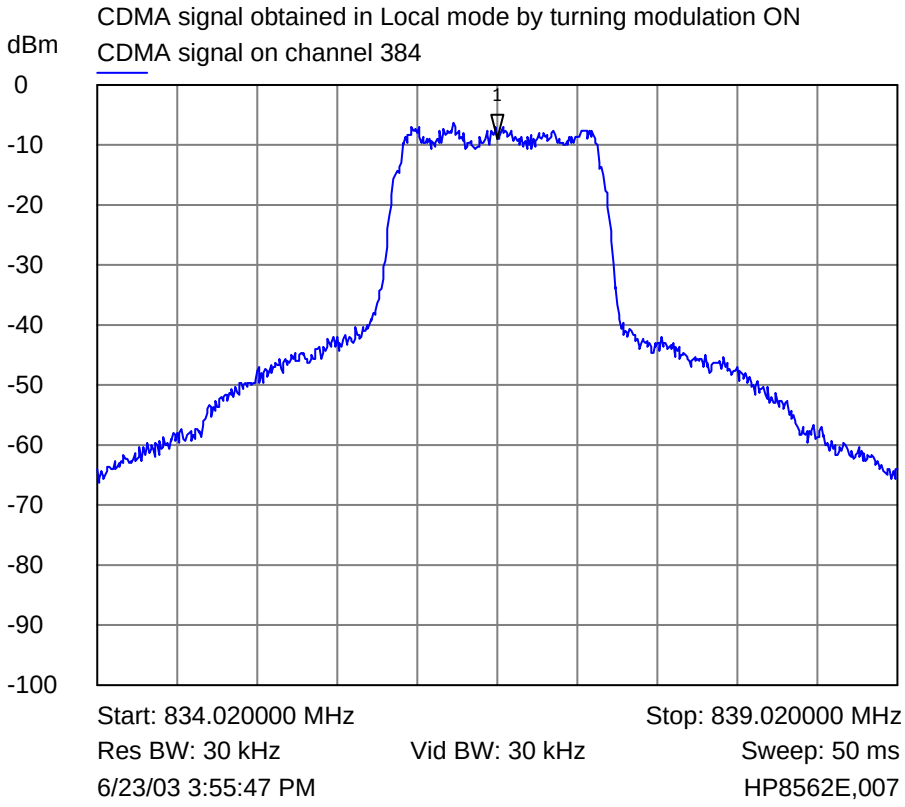

Figure 8: Tx output spectrum

To observe a Tx waveform using a spectrum analyzer:

1. Enable Local Mode on the **Phone Control** dialog box.

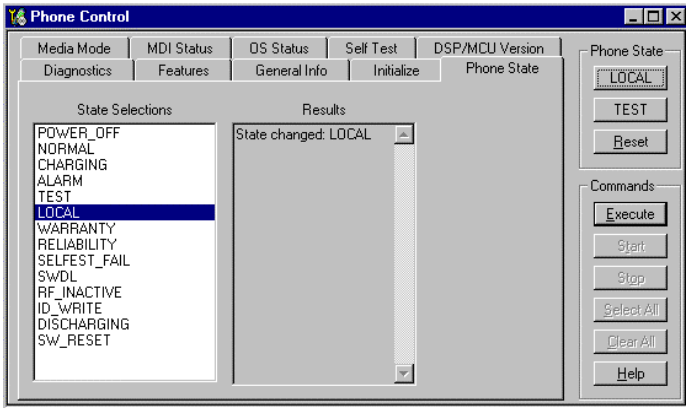

Figure 9: Enabling Local Mode on the Phone Control dialog box

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2. Select **Cell (CDMA)** in the **Band** field, and **Rx/Tx** (Tx path enabled) in the **Mode** field on the **RF Main Mode** dialog box.

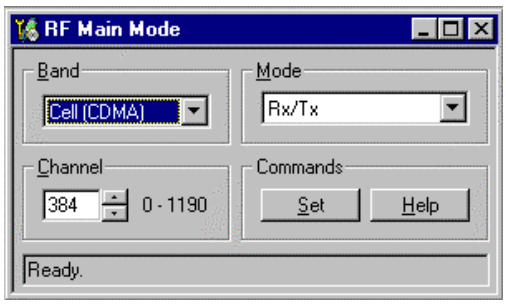

Figure 10: RF Main Mode dialog box

3. Select the **Rho ON** check box in the **State** area on the **CDMA Control** dialog box.

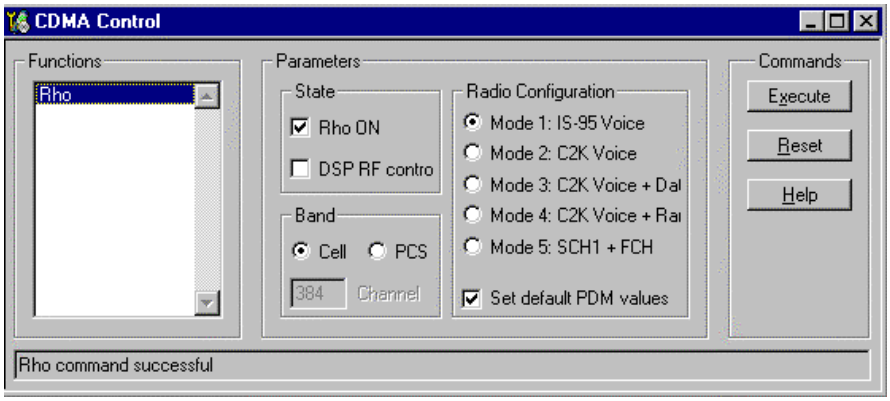

Figure 11: CDMA Control dialog box

4. Adjust the three Tx AGC settings for the proper output power level on the **RF PDM** dialog box.

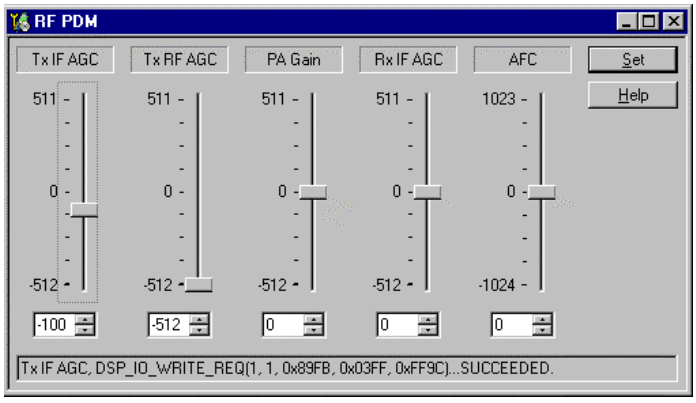

Figure 12: RF PDM dialog box

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Following are definitions of the settings on the **RF PDM** dialog box:

- Automatic Frequency Control (AFC):
  Control range from -1024 to +1023. Used as a control line to tune the VCTCXO. Monitor the change in frequency of the VCTCXO as the AFC is changed. Use in Local Mode only.
- Automatic Gain Control for Transmitter (Tx AGC):
  Consists of the Tx IF AGC, the Tx RF AGC, and the PA AGC. Used as control lines to adjust the transmitter output levels. Monitor the Tx power with call box or analyzer. Local Mode only.
- Automatic Gain Control for Receiver (Rx AGC):
  Consists of the Rx IF AGC. Used as control line to adjust the receiver input level. Local Mode use only.

Other RF Parameters in Phoenix

⑤ Gen I/O in RF

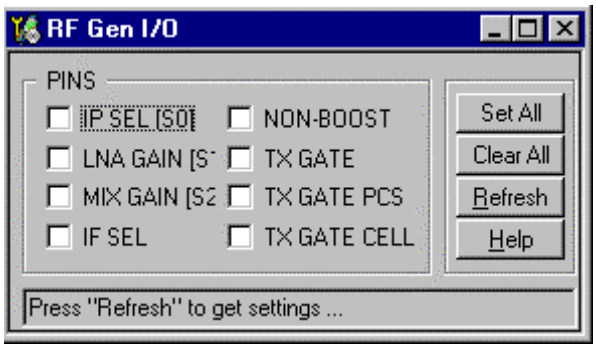

Figure 13: RF Gen I/O dialog box in RF

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⑥ RF register Read/Write in RF

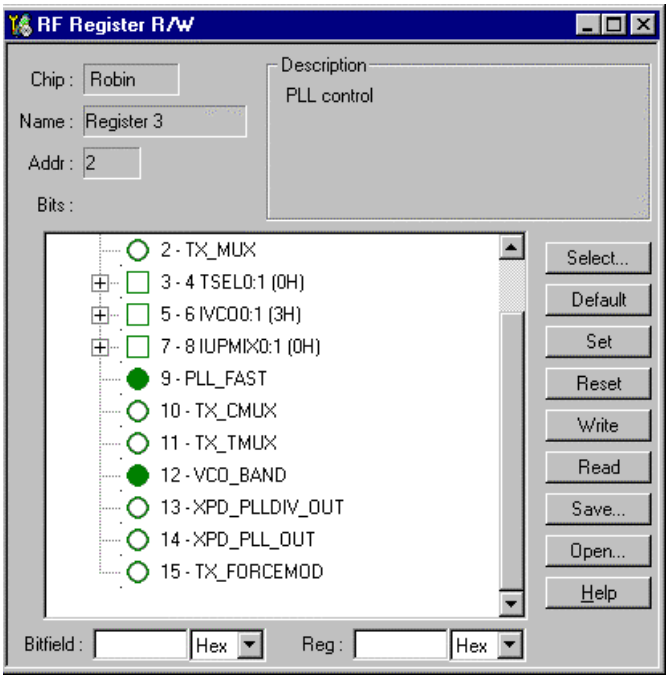

Figure 14: RF Register R/W dialog box

⑦ Frequency Calculator in RF

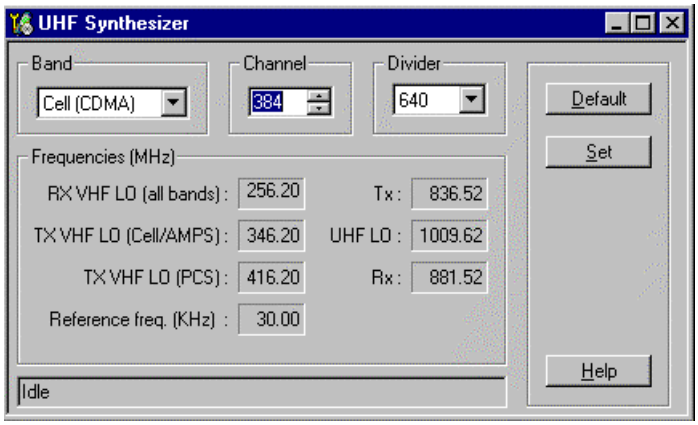

Figure 15: UHF Synthesizer dialog box

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RF Tuning Parameters in Phoenix

⑧ Batch Tune in RF

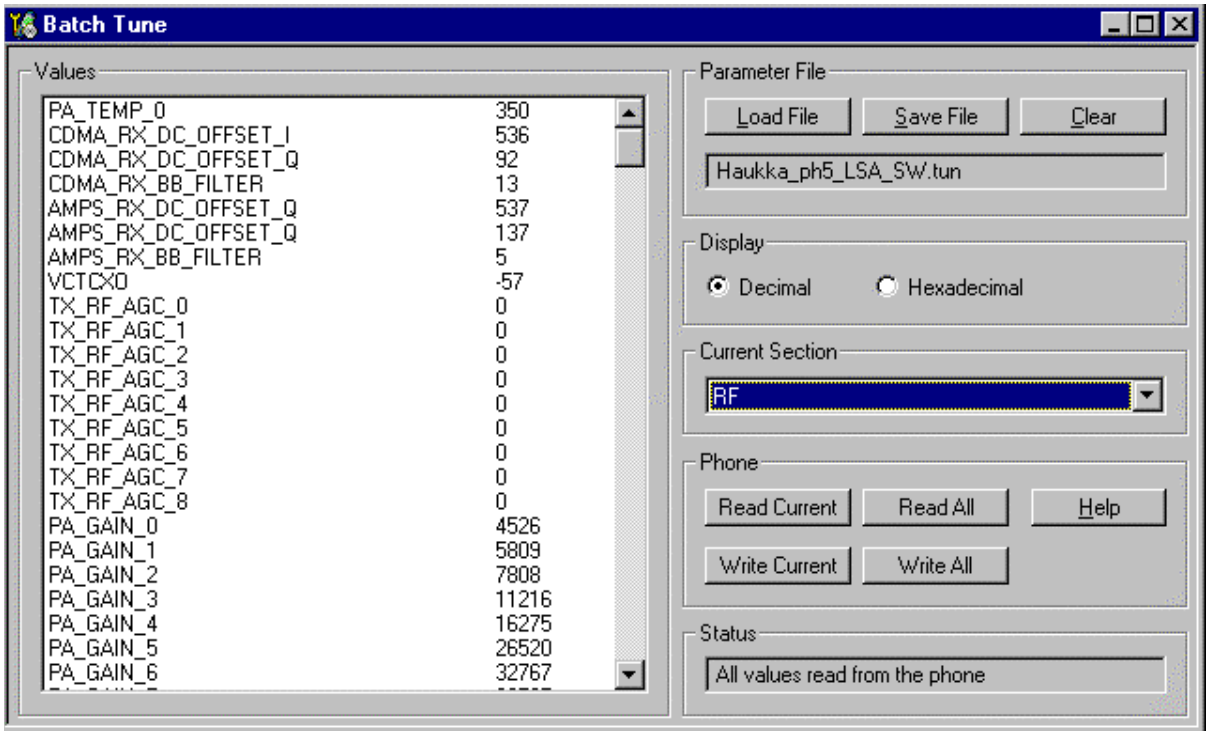


Figure 16: Batch Tune dialog box

⑨ RF Tuning in RF

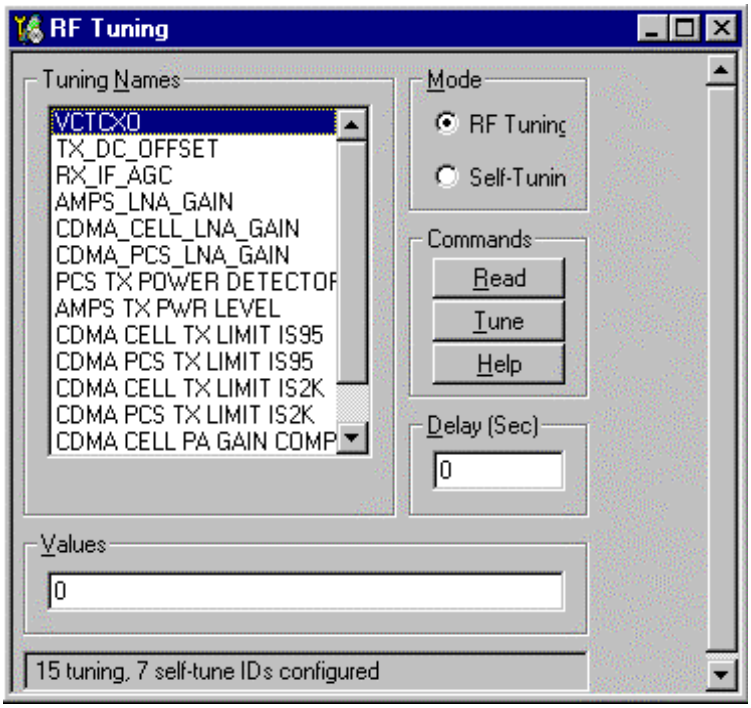
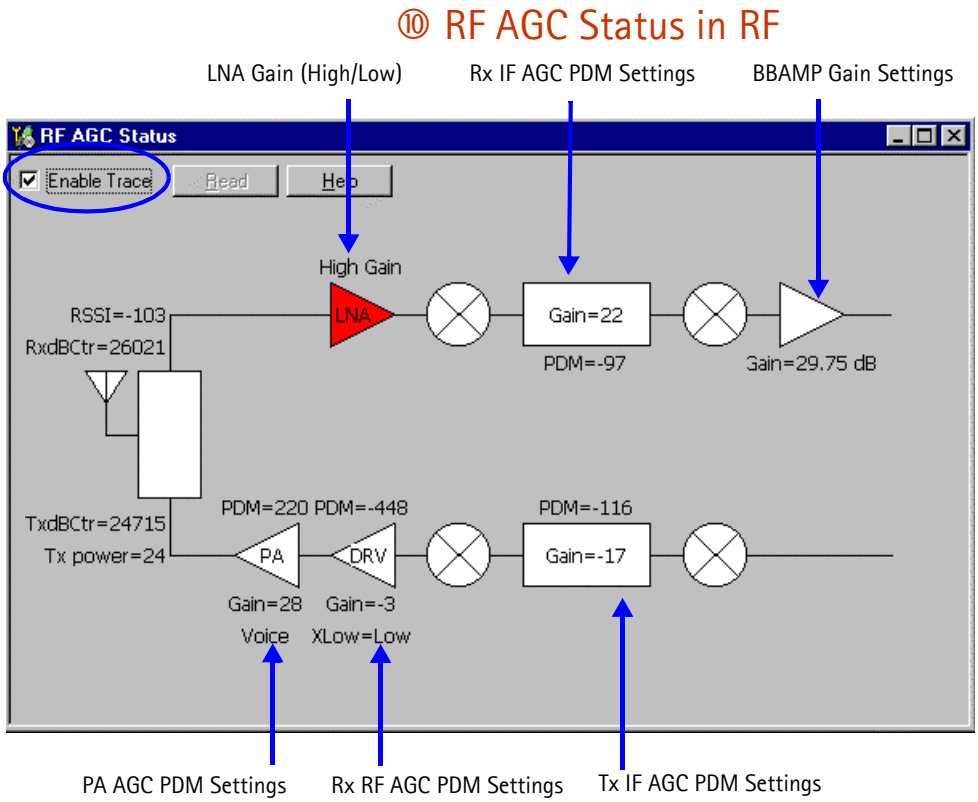


Figure 17: RF Tuning dialog box

Note: When reading the tuning parameters from the phone, always use the "Read All" button in order to read the entire set of tuning values.

RF AGC Status Components in Phoenix



Note: This RF AGC Status component only works in Call Mode. Always measure resistance with the phone powered OFF.

CDMA In-Call Testing

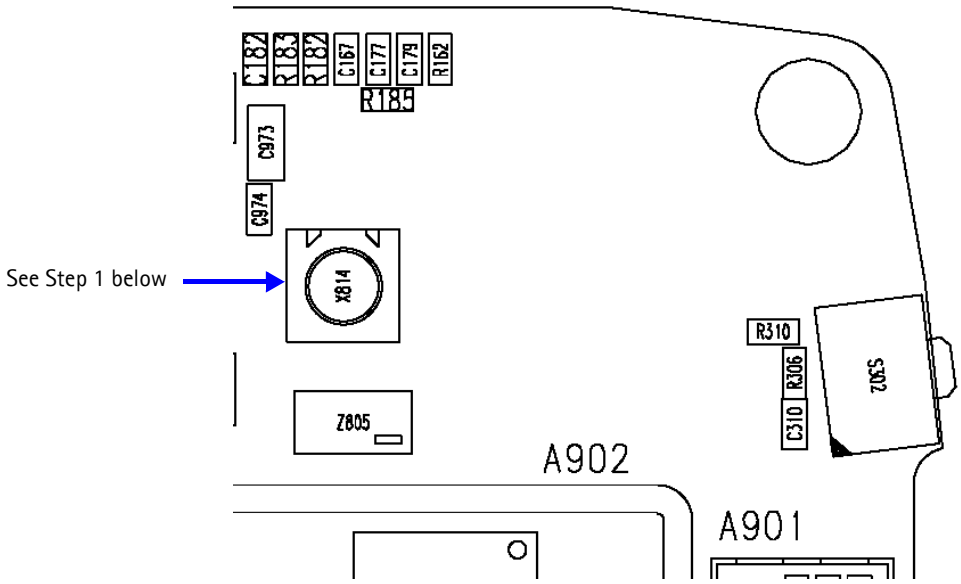


Figure 18: CDMA In-call testing

Note: There are two CDMA bands for this phone (Cell and PCS). Repeat steps 1-6 for each band to verify performance.

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1. Connect phone to call box via RF port (X814). (Add RF cable loss on call box ≅0.2 dB Cell band, ≅0.4dB PCS).
2. Power up the phone in "Normal" mode.
3. If you need to load CDMA PRL, first put the phone into Local Mode. Load the PRL; set the phone back to Normal Mode. Make sure to set the RF channel and SID according to PRL.
4. Register the phone and establish a call at –65 dBm call box sector power.
   - If you cannot register the phone, set the sector power to –25 dBm and try again.
   - If a call cannot be made in either PCS or Cell band, then proceed with Local Mode troubleshooting. (See the note following Figure 18.)
5. If the phone call is successful, open the **AGC Status** under the RF menu.
6. Select the **Enable Trace** check box on the **AGC Status** window.

CDMA in Call Testing (Low Gain)

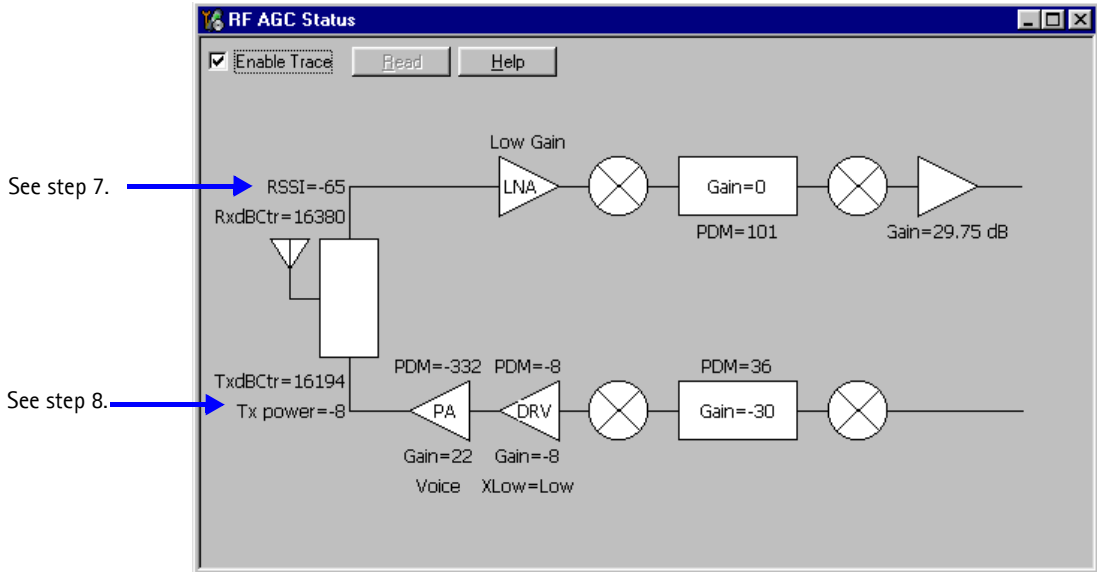

Figure 19: CDMA in call testing (Low Gain)

Table 1 includes the AGC tolerances for the Cell CDMA and PCS CDMA bands.

Table 1: AGC tolerances

Band	Rx AGC	IF AGC	RF AGC	PA AGC
Cell CDMA	>40	<40	125+-30	<-300
PCS CDMA	>40	<40	120+-30	<-300

7. In a phone call, handoff to the center channel (Ch. 600 for PCS, or Ch. 384 for Cell), and verify that the call box sector power is –65 dBm. The LNA will be in Low Gain.

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8. Compare the RSSI reading from the RF AGC status to the sector power. Compare the TX power to the digital average power on the call box. The reading should be accurate within +/- 2 dBm.
9. Verify that the cell PDMs for RX and TX are within the following tolerances:
   - Cell: Tx pwr (dBm) = -73 — RSSI
   - PCS: Tx pwr (dBm) = -76 — RSSI

CDMA in Call Testing (High Gain)

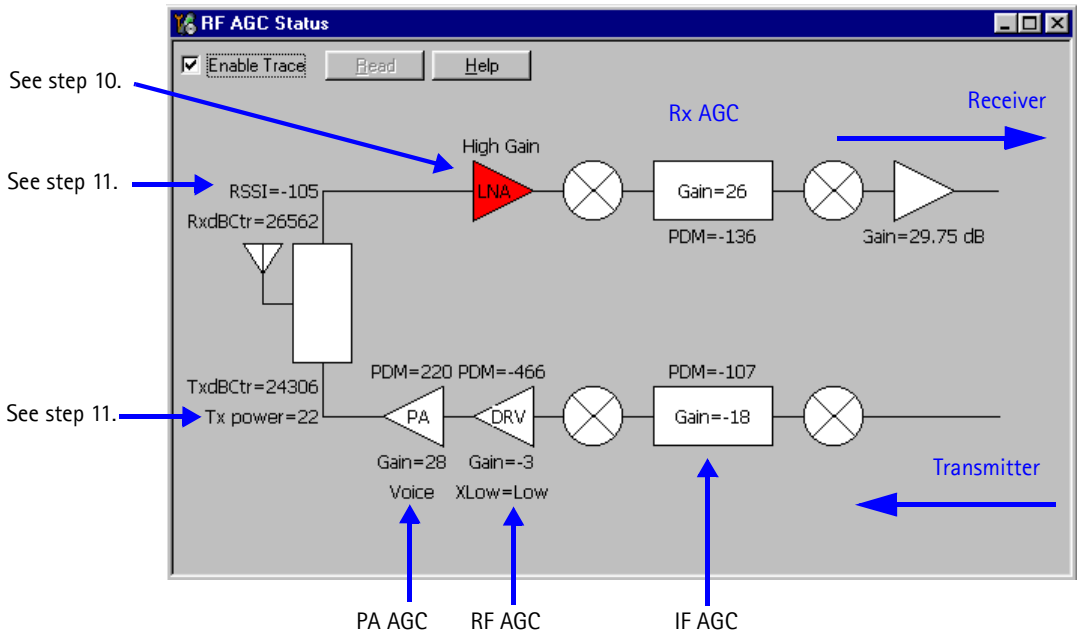

Figure 20: CDMA in call testing (High Gain)

Table 2 includes the AGC tolerances for -105 dBm input for the Cell CDMA and PCS CDMA bands.

Table 2: AGC tolerances for -105 dBm input

Band	Rx AGC	IF AGC	RF AGC	PA AGC
Cell CDMA	>-150	-115+-15	<-400	=220
PCS CDMA	>-150	-100+-20	<-400	=220

10. If steps 6-9 are OK, then adjust the call box sector power to -105dBm. This will turn the LNA to High Gain.
11. Compare the RSSI reading with the sector power on the call box. The reading should be accurate within +/- 2dB.
12. Compare the TX power to the digital average power on the call box.

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13. Verify that all PDMs for Rx and Tx are within tolerances specified in Table 2.
    - Cell: Tx pwr (dBm) = -73 — RSSI
    - PCS: Tx pwr (dBm) = -76 — RSSI

CDMA in Call Testing (AMPS)

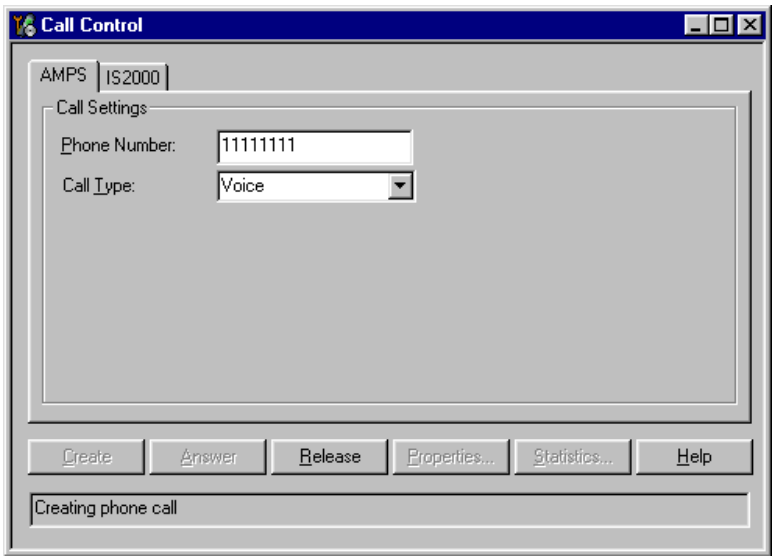

Figure 21: CDMA in call testing (AMPS)

1. Connect the phone to a call box via an RF port (X814). (Add the cable loss on the call box ≅0.2dB band.)
2. Power up the phone in Normal Mode.
3. If you need to load AMPS PRL:

   a. Put the phone into Local Mode.

   b. Load the PRL.

   c. Set the phone back to Normal Mode. (Be sure to set the Call Box control channel and SID.)

4. Use the **Call Control** option under the DSP menu. Add the 8-digit phone number and create an AMPS call.
5. If a call cannot be made, proceed with Local Mode troubleshooting.
6. Hand off to Channel 384 and PL2 using a sector power of -65 dBm.
7. Compare the RSSI reading from the **RF AGC Status** dialog box to the sector power. The value should be accurate within +/-2 dB.
8. Compare the Tx power to the digital average power on the call box. The value should be accurate within +/-2 dBm.

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Summary of Typical Cell Band PDM Readings

Following are the typical cell band PDM readings for the Low Gain state:

- RSSI = -65 dBm
- LNA = Low Gain state
- Rx IF AGC PDM = +93
- Tx IF AGC PDM = +27
- Tx RF AGC PDM = +237
- Tx PA Gain PDM = -330
- Tx Power = -11 dBm

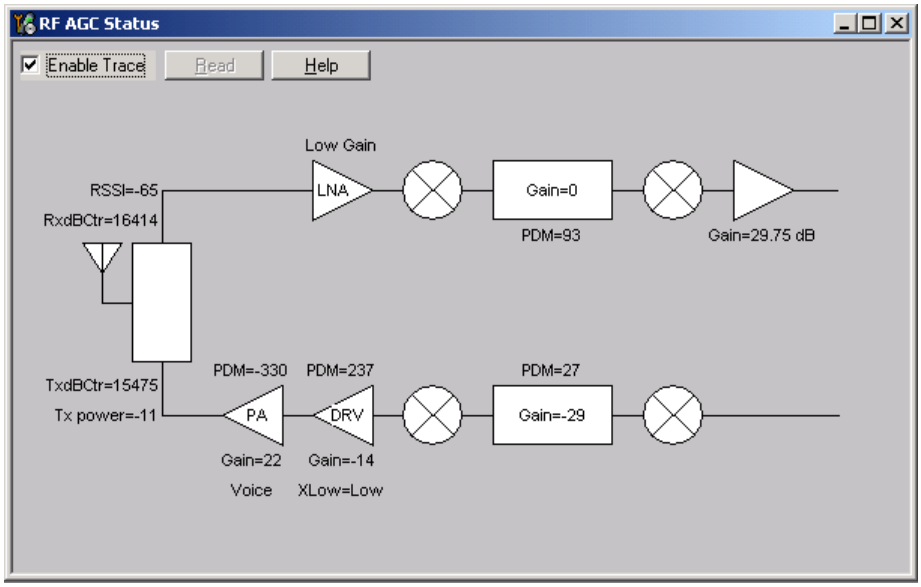

Figure 22: -65 dBm sector power CDMA channel 600

Following are the typical cell band PDM readings for the High Gain state:

- RSSI = -104 dBm
- LNA = High Gain state
- Rx IF AGC PDM = -115
- Tx IF AGC PDM = -54
- Tx RF AGC PDM = -456
- Tx PA Gain PDM = +220
- Tx Power = +19 dBm

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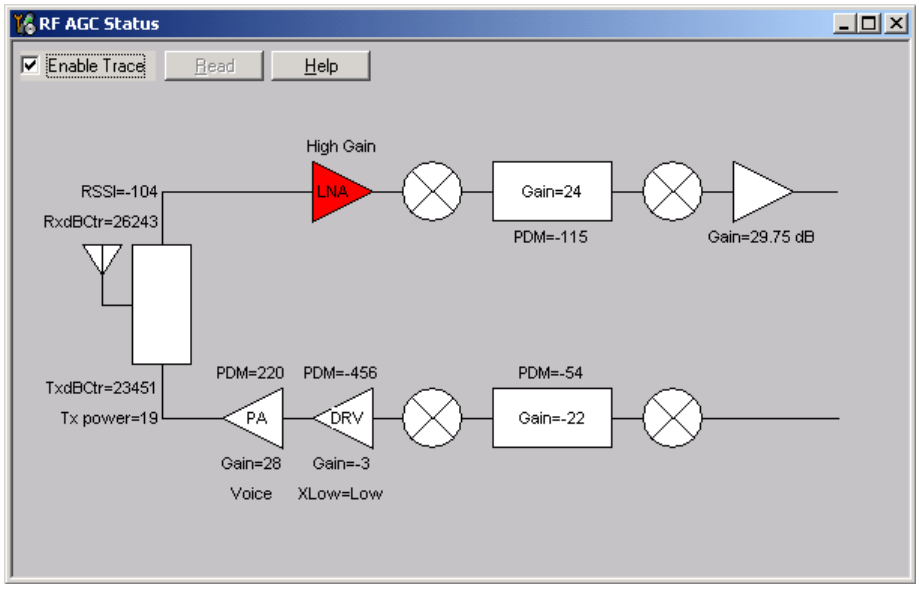

Figure 23: -104 dBm sector power CDMA channel 600

Summary of Typical PCS Band PDM Readings

Following are the typical PCS band PDM readings for the Low Gain state:

- RSSI = -65 dBm
- LNA = Low Gain state
- Rx IF AGC PDM = +54
- Tx IF AGC PDM = +24
- Tx RF AGC PDM = +125
- Tx PA Gain PDM = -327
- Tx Power = -8 dBm

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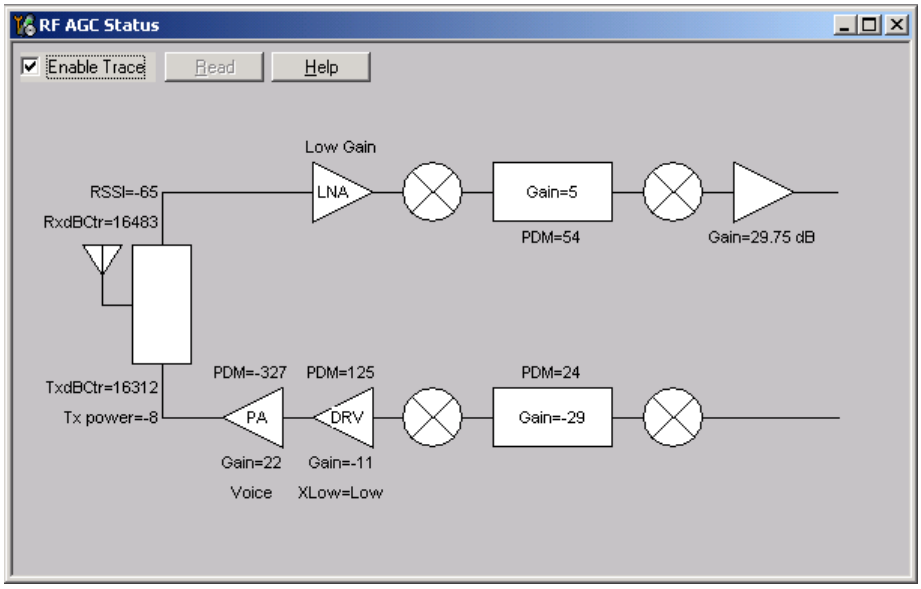

Figure 24: -65 sector power CDMA channel 384

Following are the typical PCS band PDM readings for the High Gain state:

- RSSI = -103 dBm
- LNA = High Gain state
- Rx IF AGC PDM = -127
- Tx IF AGC PDM = -85
- Tx RF AGC PDM = -450
- Tx PA Gain PDM = +220
- Tx Power = +19 dBm

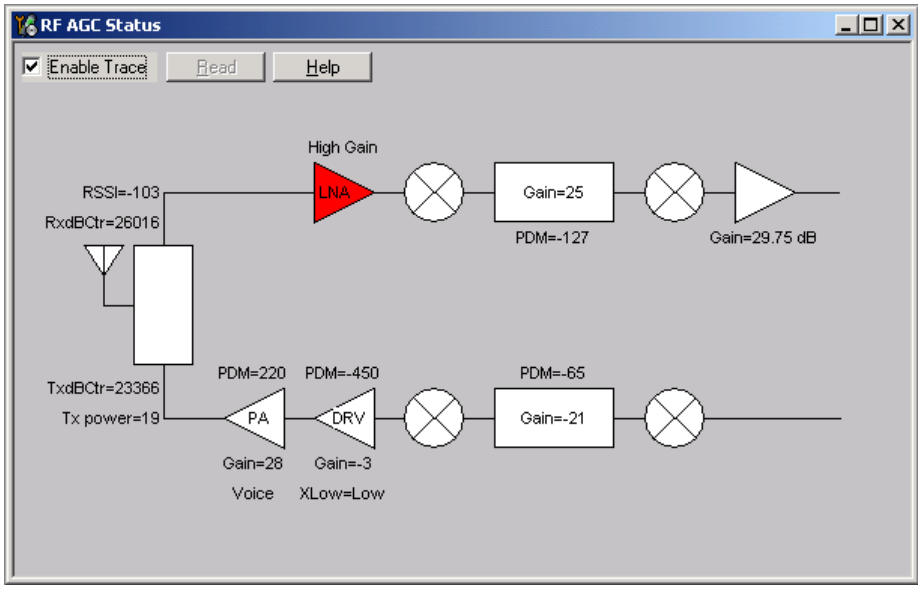

Figure 25: -104 dBm sector power CDMA channel 384

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Tx PDM Characteristic Curves (Phone Call Mode)

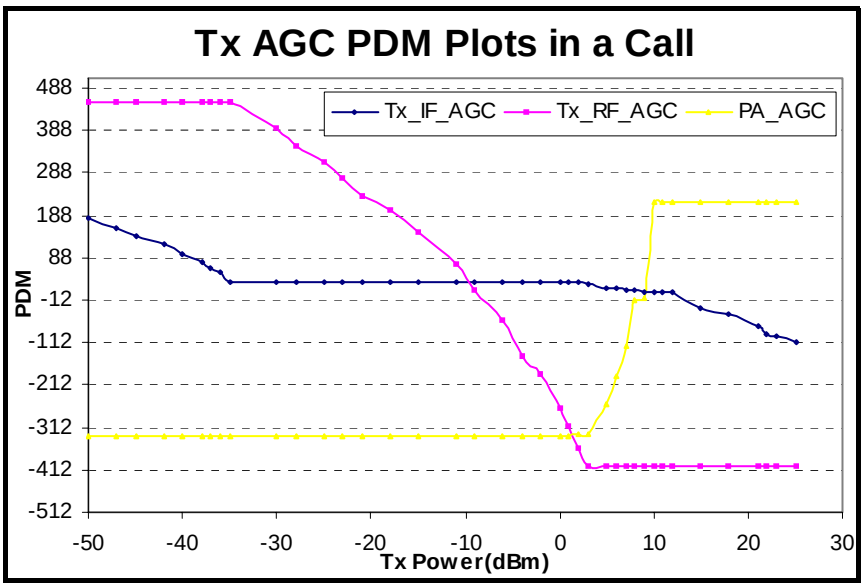

Figure 26: Tx AGC PDM plots in a call

Rx PDM Characteristic Curve (Phone Call Mode)

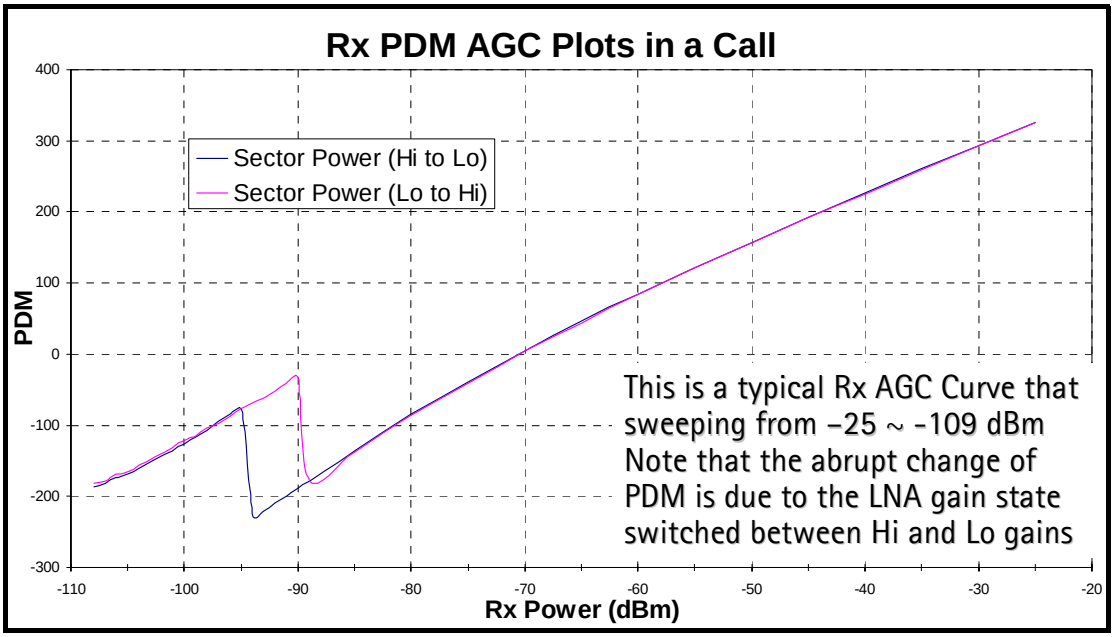

Figure 27: Rx PDM AGC plots in a call

Key RF Performance Tests in Call Mode

Tx Tests

Max Limiting Power

Set the sector power to -95dBm or lower and set the Reverse Power control bits in the 8960 to *always up*. This is the maximum limiting power that the phone can provide. Check the phone's limiting power vs. channels and see whether they are accurate to the limits. (Be sure to account for cable loss.)

Waveform Quality (rho)

This can be measured on the 8960 call box. Always measure at maximum power. The value should be greater than 0.97. The frequency error should be within +/-150Hz.

Spurious Emissions (ACPR)

ACPR can be measured on the 8960 call box. Always measure at maximum power. The limits for +/-885kHz and 1.98MHz are lower than at least -42dBc and -54dBc.

Rx Tests

Rx Sensitivity

Measure this on the 8960 call box. Always measure at max power. Rx sensitivity is defined as the minimum sector power for 0.5% FER. Usually, the result is better than -107dBm. (Be sure to account for cable loss.)

Receive Signal Strength Indicator (RSSI)

When in a call, you can verify the receiver level by using the Phoenix RF AGC component. The RSSI reading should track with the call box sector power reading within 2dB. Vary the sector power from -25dBm to -104dBm for accuracy. If the RSSI reading is off (e.g., 20dB), start the Local Mode troubleshooting.

LNA Switching (High/Low Gain State)

When in a call, you can verify at what point the LNA is turned ON (High Gain State) by using the Phoenix RF AGC component. The indicator for the LNA will turn red when it is turned ON. Usually, the LNA turns ON between -93dBm and -95dBm. If the LNA does not turn off at all in the RF AGC component while in a phone call, you will have bad sensitivity.

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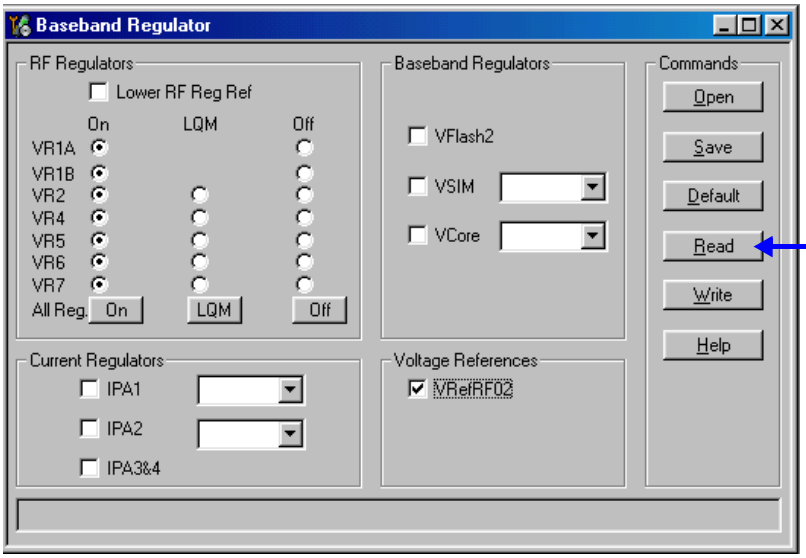
Supply Lines Measurement Using Phoenix



Before writing to the phone, read the RF regulators from the phone to determine the current state.

Figure 28: Baseband regulator component

There are 12 RF-related regulators:

- VR1A
- VR1B
- VR2
- VR3
- VR4
- VR5
- VR6
- VR7
- VrefRF1
- VrefRF2
- VIO
- VCORE

12 RF-related Supply Lines Distribution

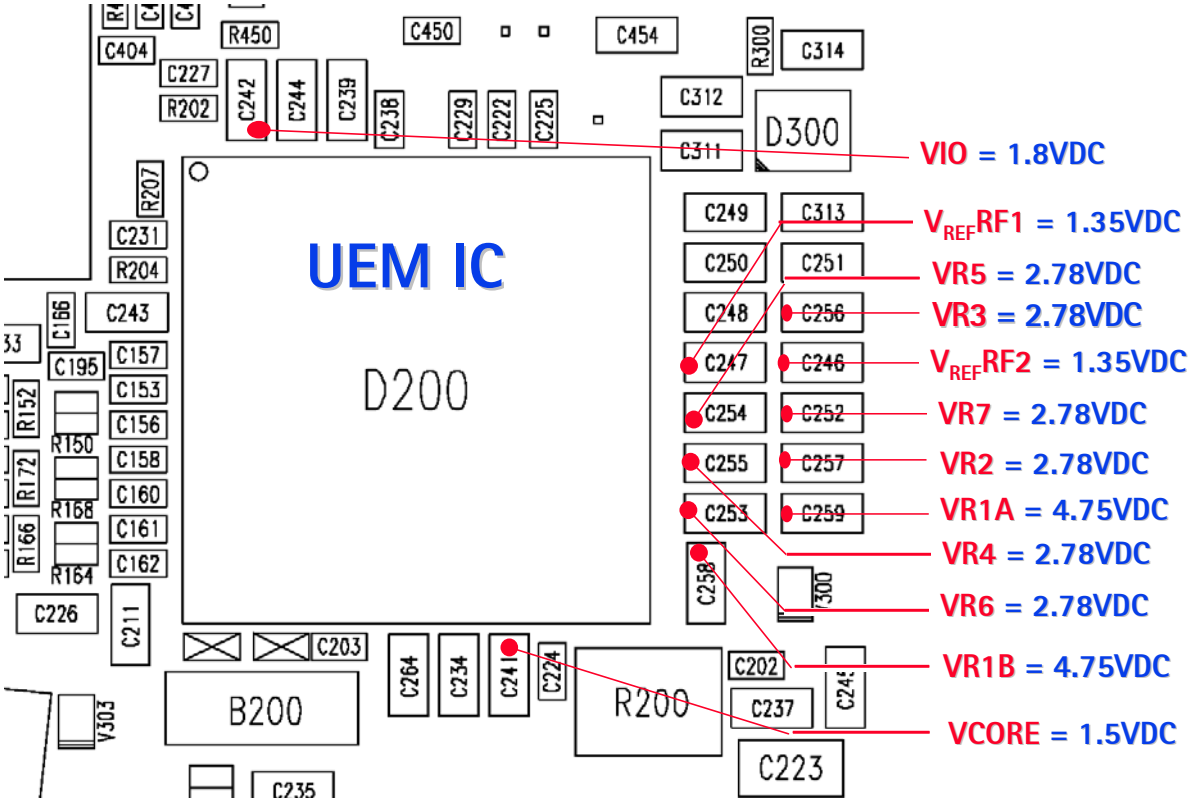


Figure 29: 12 RF-related supply lines distribution

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Supply Lines Distribution by RF Components

Component	Part Number	Supply Lines
Alfred	N750	VR5
Batman	N701	VR5, VR7, VIO, V_{REF}RF1
Robin	N601	VR2, VR3, VR6, VIO, VR1B, V_{REF}RF2
Tomcat	N603	VBAT
PA	N801	VR2, VBAT
PA Detector	N806	VR2
VCTCXO	G503	VR3, VR1A
UHF PLL	N507	VIO, VR1A
VCO	G502	VR4
VCO Buffer	N502	VR6

12 Supply Lines Resistance to Ground

Supply Line	Resistance	Components
VR1A	100kΩ to GND	Synthesizer (VCTCXO, UHF PLL)
VR1B	29kΩ to GND	Robin
VR2	4.4kΩ to GND	Robin, PA, PA Detector
VR3	4.5kΩ to GND	Robin, VCTCXO
VR4	4.7kΩ to GND	VCO
VR5	3.2~5.1Ω to GND	Alfred
VR6	39kΩ to GND	Robin, VCO Buffer
VR7	38kΩ to GND	Batman
VIO	15kΩ to GND	Batman, Robin, UHF PLL
V_{REF}RF1	45kΩ to GND	Batman
V_{REF}RF2	46kΩ to GND	Robin
VCORE	4.5kΩ to GND	UEM, UPP

Note: Always measure resistance with the phone powered OFF.

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Top RF-related Failures Seen in FLALI

Test Failed	What to Check
RF EX Self-test Batman VHF PLL	Perform Local Mode testing of Rx VHF PLL on Batman (N701). Check that voltage levels at VR5 and VR7 are 2.7V. Also, check UHF LO level into Alfred (N750).
RF EX Self-test Robin VHF PLL CELL	Perform Local Mode testing of the Tx VHF PLL on Robin (N601). Check DC voltage (VIO, VR2, VR3, VR6). Probe Tx chain in Local Mode.
RF MS TX Start-up Amplitude	Check status of soldering on the balun presence of UHF LO. Check gain of PA and driver amplifier. Driver should have 12-16dB gain and PA should have 24-28dB gain.
RFTN VCTCXO Frequency	Measure VR3, VR1A voltage and probe for 19.2MHz output of VCTCXO. Next, check if Tx VHF PLL is on frequency. If previous tests are good, probe Tx chain in Local Mode.
RF TN TX IF AGC CELL or PCS Po(X) RF TN TX PA AGC CELL or PCS Po(X) RF TN TX RF AGC CELL or PCS Po(X)	Visually check soldering of the Robin (x-ray), supporting components, and PA. Also check D400, which generates the PDM signals. Troubleshoot the rest of the TX chain in Local Mode.
RF TN TX LIM Po IS95 CELL or PCS XX	If the max TX power cannot be reached, either a component in the transmitter has too much loss or not enough gain. Troubleshoot the corresponding Cell or PCS transmitter in Local Mode.
RF TN TX DC Offset CS	If the parameter fails, check version of FLALI software to ensure that it is the latest. Also verify that the tuning limits are correct.
RF MS RX IF AGC RXdbCtr(X)	Inject signal and probe Rx chain for gain to key out any failed parts.
RF MS LNA AMPS LowGain RF MS LNA AMPS HighGain	Inject signal and probe Rx AMPS chain for gain to key out any failed parts.
RF MS LNA CELL LO LowGain RF MS LNA CELL LM LowGain	Inject signal and probe Rx Cell chain for gain to key out any failed parts.
RF MS LNA PCS xx LowGain	Inject signal and probe Rx PCS chain for gain to key out any failed parts.
GPS MS Test Mode x (all tests)	Check VL_{NA_GPS}, V_{CORE}, V_{IO}. RF Probe GPS chain.

Top RF-related Failures Seen in FINUI

Test Failed	What to Check
RF MS TX Rho PCS CH600	Rho problem is very likely caused by elevated spurious levels in UHF LO and/or by VHF Tx LO in Robin. Establish a call and verify the degraded Rho. Next probe the LO output for spurs.
RF MS RX FER PCS CH600	At this stage, FER is most likely caused by a poor RF connection. Perform a conductive RSSI measurement with sector power at -65dBm (low LNA gain) and -100dBm (high LNA gain).

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Test Failed	What to Check
RF MS RX FER CELL CH384	At this stage, FER is most likely caused by a poor RF connection. Perform a conductive RSSI measurement with sector power at -65dBm (low LNA gain) and -100dBm (high LNA gain).
RF MS SINAD	SINAD is measurement of a phone's audio quality in an AMPS call. Hence, a secured audio plug is needed to be checked for any connection problem. Verify this on the bench in an AMPS call.
RF GPS Test Mode 3	Inject signal and test SNR with the GPS self-test. If SNR is out-of-limits, then probe chain.
RF MS TX Limiting Po PCS CH25	Tx limiting power is most likely caused by a poor RF connection.
RF MS TX Limiting Po CELL CH1013	Tx limiting power is most likely caused by a poor RF connection.

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